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Is it safe using olive and green-house agroindustrial by-products in dairy goats feeding?

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Abstract. Research has focused on new alternatives of feed resources such as agro-industrial by-products because of the increase in prices of goat feeding. However there is limited information about potential toxics effect of feeding by-products on livestock production. Fifteen lactating Murciano-granadina goats were assigned to three groups (n = 5) to be fed respectively three experimental diets: Total Mixed Ratio (TMR), oat hay and glycerine (78:20:2, Control diet); TMR, tomato surplus silage and sunflower oil (SFO) (78:20:2, TSD); TMR, olive oil by-products silage and SFO (78:20:2, OSD). After 21 days adaptation period, goats were allocated in metabolic cages for 4 days, and diet, milk, faeces, urine and blood samples were collected for analyses by optical ICP for the concentration in different elements. The OSD diet had higher values of Al, Ca, Cr, Co, Cu, Fe, Li, Mg, Mn, Ni, Pb, Ti and V than control diet, while TSD showed a higher concentration of Fe. Differences in those elements appeared only in faeces of animals fed OSD and not in plasma, urine or milk samples, indicating that studied by-products used could be safely included as low cost feeding strategies.

Keywords. By-products – Livestock – Toxic effect – Elements concentration.

Est-ce que on peut utiliser sans risques les sous-produits agro-industriels de l'olive et de la production sous serre pour alimenter les chèvres laitières ?

Resumé. *Cette étude a portée sur des nouvelles alternatives de ressources alimentaires telles que les sous-produits agro-industriels en raison de la hausse des prix de l'alimentation des chèvres. Cependant, il y a peu d'informations sur l'effet potentiel de substances toxiques issues de ces sous-produits sur la production animale. Quinze chèvres laitières Murciano-Granadina ont été réparties en trois groupes (n = 5) nourris respectivement avec trois régimes expérimentaux : Ration mélangé (TMR), foin d'avoine et de la glycérine (78 : 20 : 2, Traitement contrôle) ; TMR, ensilage de l'excédent de tomate et l'huile de tournesol (SFO) (78 : 20 : 2, TSD) ; TMR, ensilage des sous-produits d'huile d'olive et SFO (78 : 20 : 2, OSD). Après une période de 21 jours d'adaptation, les chèvres ont été placées dans des cages métaboliques pendant 4 jours. Un prélèvement du régime alimentaire, fèces, urine et sang a été réalisé en vue de leur analyse par ICP pour le dosage des différents éléments. Le régime OSD présentait des valeurs plus élevées en Al, Ca, Cr, Co, Cu, Fe, Li, Mg, Mn, Ni, Pb, Ti et V par rapport au régime Contrôle, alors que le régime TSD a montré une plus forte concentration en Fe. Ces différences ne sont apparues que dans les fèces des animaux nourris avec le régime OSD, alors qu'aucune différence significative n'a été retrouvée dans les échantillons de plasma, urine ou lait. Ceci montre que les sous-produits étudiés pourraient être inclus sans aucun risque dans les stratégies d'alimentation à moindre prix.*

Mots-clés. *Sous-produits – Élevage – Effets toxiques – Concentration d'élément.*

I – Introduction

The increase in goat feed prices and the associated farming costs limit livestock production. In the last years a rapid intensification of the sector has occurred in response to the poor quality and scarcity of pastures, the use of breeds with a high productive potential, the lack of shepherds or the need to reduce seasonality in meat and milk production. This has resulted in a significant replacement of extensive systems by intensive or semi-intensive systems (Castel *et al.*, 2011). This intensification of dairy goat production systems enhances the dependence of high input animal feeding on grain concentrates and conserved forages, especially hay in south Spain (Castel Genis *et al.*, 2007). To address this problem research has focused on new alternatives of feed resources such as agro-industrial by-products. Tomato surplus and olive oil by-products have proven to be valid ingredients in goats feeding, by replacing conventional ingredients either concentrate (Molina-Alcaide *et al.*, 2010; Romero-Huelva *et al.*, 2012) or forage as silage (Arco-Pérez *et al.*, unpublished data). However there is limited information about potential toxic effect of feeding by-products to livestock (Molina-Alcaide and Yáñez-Ruiz, 2008).

II – Material and methods

Fifteen lactating Murciano-Granadina goats (50.5 ± 6.6 kg), in their second month of lactation, were used. Animals were cared and handled in accordance with the Spanish guidelines for experimental animal protection (Royal Decree 53/2013) in line of corresponding European Directive (2010/63/EU). Animals were placed in individual boxes and had permanent free access to water. Goats were assigned to three homogeneous groups (n = 5) balanced according to body weight and milk yield, to be fed respectively three experimental diets twice a day at 9:00 h and 14:00 h. Experimental diets were formulated as follows: Control Diet: Total Mixed Ratio, based on chopped alfalfa (*Medicago sativa*) hay plus grain mixture (TMR), oat hay (*Avena sativa*) and glycerin (78:20:2). Olive by-products diet (OBSD): TMR, olive by-products silage and sunflower oil (SFO) (78:20:2). Tomato surplus diet (TSD): TMR, tomato surplus silage and SFO (78:20:2). Proportions are expressed in dry matter. Tomato silage contained, in fresh matter, 850 g/kg greenhouse tomato surplus and 150 g/kg barley straw. Olive oil by-products silage contained olive leaves, olive cake (from olive oil extraction process) and barley flour, in the proportion 2:1:1 in fresh matter. Bates were opened after 70 days of ripening. The dry matter was 315±15 and 508 ± 25 g/kg of fresh matter respectively for tomato and olive by-products silages. The specific N and energy requirements of lactating goats were considered in the dietary formulation (Aguilera *et al.*, 1990). The amount of feed supplied to the animals was adequate to allow daily milk production of up to 2 kg per goat.

After a 21 days adaptation period, goats were allocated in metabolic cages for 4 days (23-26), and dry matter intake (DMI), milk, faeces and urine excretion were daily recorded and samples collected to be analysed. Ten millilitres of blood samples were collected from each animal in vacuum tubes with lithium heparin by jugular venipuncture on day 26. Diets, faeces, urine, milk and plasma samples were analysed by optical ICP (ICP-OES ICAP 6500 DUO/IRIS INTREPID II XDL) for elements concentration by the Ionomic Service of CEBAS-CSIC (Murcia, Spain).

The SPSS for Windows software (version 21.0, 2010; SPSS Inc., Chicago, IL) was used for data entry and statistical analysis by one-way ANOVA. When a significant effect of diet was found, post hoc comparison of means was made using the least significant difference test: $\alpha_c = 1 - (1 - \alpha)^k$, where α_c is the comparison wise error rate, α is the significance level, and k is the number of comparisons performed. Differences were considered significant at $P < 0.05$, and $P < 0.10$ values were declared as trends.

III – Results and discussion

The OBSD diet had higher values of Al, Ca, Cr, Cu, Fe, Li, Mg, Mn, Ni, Pb, Ti and V than Control diet (Table 1). The abundance in Al could be ascribed to the use of aluminum lignosulfonate as complexing agent in micromineral mixtures. Olive leaves are rich in Ca because limestone soil is predominant in the study area. Copper based fungicides are widely used in the olive groves to control fungal diseases (Roca *et al.*, 2007). The scarcity of microelements, despite its low proportion in the olive, can have catastrophic consequences for the performance and for the chlorophyll activity of the plant (Llona-García *et al.*, 1999), and thus micromineral mixtures (containing Fe, Mn, Mg and Ti) are often applied to crops. Vegetable oils are rich in vanadium, which may explain its high content in OBSD.

Table 1. Silages and diets elements content (mg/kg)

	Olive by-products silage	Tomato surplus silage	Control	OBSD	TSD
Al	**7143**	**898**	**283**	**1203**	**501**
As	2.71	0.76	0.56	0.81	0.64
Ca	62861	9565	6496	13737	7030
Cd	<0.010	<0.010	<0.010	<0.010	<0.010
Co	<0.010	<0.010	<0.010	<0.010	<0.010
Cr	13.3	2.32	2.79	6.25	4.77
Cu	45.7	9.96	6.64	12.4	7.28
Fe	4363	1167	279	930	505
Hg	<0.010	<0.010	<0.010	<0.010	<0.010
K	8275	12865	10963	8344	9057
Li	7.58	1.14	0.6	1.56	0.78
Mg	7390	2294	1770	2690	1984
Mn	168	36.0	37.5	44.11	33.8
Mo	1.24	0.61	1.32	1.13	1.02
Na	1063	635	1401	951	923
Ni	6.63	1.4	2.75	3.98	3.1
P	1300	1247	2541	2529	2525
Pb	5.93	1.17	<0.010	0.9	<0.010
S	1714	1270	2264	2084	2030
Se	5.77	5.16	4.34	5.26	4.51
Ti	97.8	15.7	7.89	17.48	12.92
V	12.0	1.69	0.53	2.11	0.89
Zn	45.1	18.1	31.5	32.6	26.3

The higher proportion of some heavy metals in OBSD (Fe, Cr and perhaps Pb) may be also attributed to the industrial manipulation process of the olive cake for oil extraction.

The TSD diet showed a high concentration in iron, which use is also very common in greenhouse cultivations.

Elements in blood, milk and urine did not show significative differences among animals consuming the different experimental diets, appearing only in faeces of animals fed OSD and showing a similar relative abundance among elements than the observed in the corresponding diet consumed (Tables 2 and 3). Preliminary studies on the balance and bioavailability of the elements showed that experimental diets have no higher toxic potential than control diet as the low absorption of toxic elements along the gut of dairy goats fed tomato surplus and olive oil by-products. Thus, for OSD, the absorption rate of Al, Pb, Li, Mn and Ti was zero, while for Cr it was 25-30% lower for this diet compared to the others, compensating the observed excess of Cr in this diet. This is supported by the absence of differences of elements composition in biological fluids of animals fed different experimental diets and because excess of the elements detected in diet was excreted in faeces, indicating that they could be safely included in low cost feeding strategies for lactating goats. In conclusion, the presence of metals and potential toxic elements in agro-industrial by-products potentially does not affect animals´ health. However, longer-term trials need to be performed to confirm such observation and to rule out any public health concern.

Table 2. Milk and plasma detected elements composition (mg/L)

	Plasma					Milk				
	Control	OBSD	TSD	SEM	P Value	Control	OBSD	TSD	SEM	P Value
Al	0.106	0.178	0.067	0.036	0.458	0.239	0.349	0.198	0.057	0.556
Ca	93.1	95.2	97.2	1.60	0.588	1392	1448	1505	40.0	0.538
Cu	1.37	1.37	1.29	0.040	0.705	0.146	0.119	0.101	0.008	0.133
Fe	2.31	2.69	2.49	0.250	0.822	0.413	0.406	0.414	0.014	0.968
K	170	165	168	3.000	0.808	1090	1227	1124	30.0	0.192
Li	4.68	5.17	4.55	0.110	0.096	N. D.	N. D.	N. D.		
Mg	22.7	24.2	24.3	0.700	0.598	140	150	133	4.00	0.318
Mn	N. D.	N. D.	N. D.	0.083	0.059	0.071	0.004	0.050		
Na	3629	3551	3709	25.0	0.070	470	419	464	48.0	0.897
P	129	144	122	7.00	0.427	1449	1454	1420	57.0	0.965
S	1353	1248	1320	20.0	0.127	471	440	425	10.0	0.196
Zn	0.816	0.767	0.840	0.027	0.542	4.24	4.94	4.69	0.320	0.670

N.D., not detected.

Table 3. Faeces and urine elements content

	Faeces ppm (mg/kg)					Urine ppm (mg/L)				
	Control	OBSD	TSD	SEM	P	Control	OBSD	TSD	SEM	P
Al	913 a	4674 b	1691 a	193	0.000	0.304	0.107	0.175	0.069	0.519
As	0.100	0.110	0.100	0.002	0.397	0.000 a	0.026 b	0.010 ab	0.004	0.052
Be	0.500	0.500	0.500	0.000	1.000	N. D.	N. D.	N. D.		
Bi	0.500	0.500	0.500	0.000	1.000	N. D.	N. D.	N. D.		
B	9.12 a	20.4 b	11.1 a	0.965	0.001	9.470	10.5	13.3	1.44	0.541
Ca	10800 a	24200 b	11700 a	880	0.000	126	69.1	65.3	20.2	0.421
Cd	0.100	0.100	0.100	0.000	1.000	N. D.	N. D.	N. D.		
Co	0.500	0.500	0.500	0.000	1.000	0.100	0.080	0.000	0.030	0.289
Cr	2.36 a	8.59 b	3.86 a	0.330	0.000	N. D.	N. D.	N. D.		
Cu	21.7 a	39.5 b	24.7 a	1.11	0.000	0.050	0.035	0.032	0.011	0.758
Fe	808 a	2951 c	1522 b	108	0.000	1.45	1.18	1.41	0.269	0.911
K	0.699	0.683	0.504	510	0.266	9030	8397	11253	1126	0.569
Li	0.770a	4.50 b	1.45 a	0.199	0.000	0.220	0.302	0.292	0.047	0.740
Mg	0.260 a	0.480 b	0.310 a	210	0.002	730	864	999	103	0.582
Mn	114 a	150 b	110 a	5.20	0.015	3.25	4.25	3.84	0.393	0.593
Mo	3.61	3.44	3.36	0.148	0.787	0.055	0.059	0.064	0.010	0.942
Na	0.077	0.072	0.077	80.0	0.942	774	521	582	105	0.602
Ni	4.36 a	5.67 b	4.09 a	0.177	0.007	0.028	0.004	0.017	0.005	0.213
P	0.878	0.634	0.687	480	0.131	136	134	53.5	33.5	0.535
Pb	2.39 a	6.53 b	3.18 a	0.232	0.000	0.149	0.094	0.174	0.021	0.332
S	0.220 a	0.280 b	0.230 a	80.0	0.018	7700	7227	7841	1016	0.967
Sb	0.500	0.500	0.500	0.000	1.000	N. D.	N. D.	N. D.		
Se	0.100 a	0.520 b	0.120 a	0.034	0.000	0.010	0.000	0.010	0.004	0.465
Sr	199 a	394 b	170 a	10.9	0.000	5.03	3.48	4.75	0.640	0.587
Ti	37.2 a	74.5 b	41.9 a	2.08	0.000	0.002	0.000	0.000	0.001	0.397
Tl	1.77 a	15.2 b	5.79 a	1.08	0.001	2.247	3.09	3.14	0.363	0.546
V	1.35 a	6.77 b	2.49 a	0.278	0.000	N. D.	N. D.	N. D.		
Zn	331	307	239	37.6	0.600	32.6	10.8	28.0	6.80	0.411

N. D., not detected.

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References

Aguilera J.F., C. Prieto and J. Fonollá., 1990. Protein and energy metabolism of lactating Granadina goats. *Br. J. Nutr.*, 63, p. 165-175.

Castel J.M., Y. Mena, F.A. Ruiz, J. Camúñez-Ruiz and M. Sánchez-Rodríguez, 2011. Changes occurring in dairy goat production systems in less favoured areas of Spain. *Small Ruminant Research*, 96, p. 83-92.

Castel Genis J., Y. Mena and Asís-Ruíz F., 2007. Junta de Andalucía El sector caprino y su contribución al desarrollo rural. In: *Agricultura Familiar en España*, pp. 246-257. (EUITA. Universidad de Sevilla Francisco de Asís Ruiz IFAPA).

Llona-García J.M., J.F. Moldenhauer-Gómez, F.R. Gámiz-Cerrillo, C.A. Pérez-Jiménez, P. Ramos-Pedregosa, J. Romero-Ruiz and J.L. Sánchez-Garrido y Reyes, 1999. *El olivo, un árbol para la historia. Aproximación a su riego y fertilización, y otros comentarios*. Herogra Fertilizantes S.A.

Molina-Alcaide E. and D.R. Yáñez Ruiz, 2008. Potential use of olive by-products in ruminant feeding: A review. *Animal Feed Science and Technology*, 147, p. 247-264.

Molina-Alcaide E., E.Y. Morales García, A.I. Martín García, H. Ben Salem, A. Nefzaoui and M.R. Sanz Sampelayo, 2010. Effects of partial replacement of concentrate with feed blocks on nutrient utilization, microbial N flow, and milk yield and composition in goats. *Journal of Dairy Science*, 93, p. 2076-2087.

Roca L.F., J. Moral, J.R. Viruega, A. Ávila, Rodrigues Oliveira and A. Trapero, 2007. Copper fungicides in the control of olive diseases. *FAO Olive Network*, 26, p. 48-50.

Romero-Huelva M., E. Ramos-Morales and E. Molina-Alcaide, 2012. Nutrient utilization, ruminal fermentation, microbial abundances, and milk yield and composition in dairy goats fed diets including tomato and cucumber waste fruits. *J. Dairy Sci.*, 95, p. 6015-6026.